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Studies on seasonal incidence of plume moth, *Sphenarchus caffer* Zeller in Dolichos Bean, *Lablab purpureus* L. and its relation with abiotic factors

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Abstract
The present study was carried out to find the correlation between the seasonal incidence of plume moth, *Sphenarches caffer* with weather variables during *kharif* 2015-16 and *kharif* 2016-17 respectively. The results revealed that the standard week wise data pertaining to plume moth *S. caffer* population during *kharif* 2015-16 revealed that the highest population incidence was recorded with two peaks i.e., once at 47th standard week and second one at 49th standard week with 3.0 and 3.3 larvae per plant, respectively, while during *kharif* 2016-17 the highest population incidence of *S. caffer* was observed with two peaks *i.e.* once at 49th standard week and second one at 50th standard week with 2.8 and 3.7 larvae per plant, respectively. The observations on the relationship between plume moth, *S. caffer* larval population with preceding one week (one week lag) weather parameters during *kharif* 2015-16 revealed that there was a significant negative correlation with maximum temperature (-0.427*) and evaporation (-0.517*) at 5 % level of significance whereas significant positive correlation with evening relative humidity (0.074*) at 5 % level of significance. During *kharif* 2016-17 minimum temperature (-0.293*) and evaporation (-0.676**) were negatively significant with *S. caffer* larval population at 5% level and 1% level of significance, respectively while evening relative humidity (0.186*) was positively significant at 5 % level of significance.

Keywords: Field bean, seasonal incidence, plume moth, *S. caffer* and correlation

1. Introduction
Lablab purpureus (L.) Sweet. popularly known as field bean, hyacinth bean, dolichos bean, country bean, butter bean, and Indian bean which is an important pulse cum vegetable crop in India and is cultivated extensively in the recent past for its fresh tender pods, leaves and seeds and as cattle feed. The fresh and dried seeds constitute a major vegetarian source of proteins in the human diet of Indians. The primary cause attributed for lower yields of field bean can be due to the heavy infestation of an array of pest complex.

As many as 55 species of insects and a species of mite feeding on the crop from the seedling stage to the harvest of the crop in Karnataka [1]. An extent of 80 to 100 per cent crop loss was recorded due to the pod bores damage in field bean [2]. Pod borers complex was the major problem for the low productivity in Indian conditions which sometimes incur the loss to a tune of nearly 54 per cent in Dolichos beans [3]. The major yield loss was inflicted by the pod feeders which include both the pod borers and pod bugs.

The pod borer complex includes *Maruca testulalis* (Geyer), *Helicoverpa armigera* (Hubner), *Adisura atkinsoni* (Moore), *Etiellazinckenella* (Treitschke), *Cydia ptychora* (Meyrick), *Sphenarchus caffer* Zeller, *Exelastis atomosa* (Walshinghan) and *Lampides boeticus* (Linnaeus), The spotted pod borer, *Maruca testulalis* is an important insect pest of grain legumes appear on the crop from vegetative to reproductive stage and cause substantial damage to flowers, by webbing and also boring into the pods. The damage inflicted by *H. armigera* is generally confined to flower heads, seeds and pods. Plume moth attacks the crop at thestage of flowering and continues up to pod maturity. The young larvae of *L. boeticus* damage flowers and pods [4]. Hence to know the insect pest scenario on the crop, the studieshave planned.

2. Materials and Methods

To study the seasonal incidence of *Sphenarchus caffer* the field bean crop was grown by raising 100 m^2 crop with a spacing of 90 x 20cm. The study was carried out during *Kharif* 2015 and 2016 in open field located in horticulture garden, College of Agriculture, Rajendranagar, Hyderabad. All the recommended routine agronomic practices except plant protection measures were followed for raising the crop. From the date of germination onwards, observations were made in the bulk plots in ten selected plants for infestation of the insects at weekly interval. To assess the incidence of plume moth *S. caffer* the observations were made at a weekly interval commencing from randomly selected ten plants by counting the number larvae per plant. The data obtained in the seasonal incidence studies *S. caffer* on field bean were subjected to correlation and multiple regression with various weather parameters *viz*., maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, rainfall, sunshine hours, evaporation *etc*.

3. Results

3.1 Seasonal incidence of *S.caffer* on field bean during *kharif* 2015- 16 and 2016-17

The seasonal incidence data pertaining to plume moth, *S. caffer* (Figure 1a and b) was collected from randomly tagged ten field bean plants at weekly intervals from an unprotected crop raised during *kharif* 2015-16 and 2016-17. The standard week wise data pertains to mean plume moth population per plant data from germination to harvest during *kharif* 2015-16 and 2016-17 were presented in tables 1 and 2, respectively (Figure 2).

3.1.1 *Kharif* 2015-16

The data pertaining to the incidence of *S. caffer* was presented in table 1.

The data indicated that, the incidence of the larvae on field bean was initiated during the third week of October (42nd standard week) in *kharif* 2015-2016 with 0.1 larvae/plant and the population of the plume moth ranged between 0.1 to 3.3 lavae per plant during entire crop growth period.

The population reached peak during 3rd week of November (47th standard week) and once again during the first week of December (49th standard week) by 3.0 and

3.3 larvae per plant, respectively. Later the plume moth population decreased gradually by the end of the *kharif* season reaching 0.1 larvae per plant at last week of January

(4th standard week). The highest number of 3.3 larvae per plant was recorded in the

1st week of December 2015 (49th standard week).

3.1.2 *Kharif* 2016-17

The data pertaining to incidence of *S. caffer* was presented in table 2. The data indicated that, the incidence of the larvae was started in the 41st standard week during

kharif 2016-17 (08th to 14th October) with 0.2 larvae/plant. The population ranged in between 0.1 to 3.7 larvae/ plant during entire crop growth period.

The population gradually reached peak during the second week of December

(50th standard week) by 3.7 larvae per plant. Later the plume moth population decreased gradually by the end of the *kharif* season reaching 0.1 larvae per plant at last week of January (4th standard week). The highest number larvae per plant (3.7) were recorded in the 2nd week of December 2016 (50th standard week).

3.2 Effect of abiotic factors between larval population of *S. caffer* and weather parameters during *kharif* 2015-16 & 2016-17

The correlation studies conducted between the *S.caffer* population and weather parameters of one week lag during *kharif* 2015-16 and 2016-17 were presented in table 3. Multiple Regression model developed for the population of *S. caffer* with preceding one week weather parameters (one week lag) during *kharif* 2015-16 and *kharif* 2016-17 were presented in table 4.

3.2.1 *Kharif* 2015-16

The data pertaining to the relationship between the seasonal incidence of

S.caffer with the preceding one week weather parameters (one week lag) during *kharif* 2015-16 crop revealed that, maximum temperature (-0.427*) and evaporation (-0.517*) shown significant negative correlation (p=0.05) with *S.caffer* population, while, evening relative humidity (0.074*) had significant positive correlation (p=0.05) with plume moth population. Morning relative humidity (0.041) shown positive non significant correlation with *S. caffer* larval population, whereas, minimum temperature (-0.243), rainfall (-0.047),

rainy days (-0.107), sunshine hours (-0.229), wind speed (-0.129) and mean temperature (-0.352) were negatively non significant with larval population of *S. caffer* (Table 3).

3.2.2 Multiple regression for *Kharif* 2015-16

Regression analysis revealed that, all weather parameters collectively influenced the *S.caffer* larval population to the extent of 84.20 per cent (R^2 =0.84%) on field bean (Table 4).

Multiple regression equation was developed for *S.caffer* larval population with preceding one week weather parameters (one week lag) was presented in table which indicated that increase in one unit of maximum temperature, minimum temperature, evening relative humidity, rainfall, mean sunshine hours and wind speed resulted in the increase of *S.caffer* larval population by 2.69, 2.95, 1.01, 10.86, 1.08 and 0.36 units, respectively. Further, with one unit increase in morning relative humidity, rainy days, mean evaporation and mean temperature resulted in a decrease in larval population by 0.71, 11.60, 1.86 and 3.62 units respectively in field bean.

3.2.3 K*harif* 2016-17

The correlation studies between the seasonal incidence of *S.caffer* with the preceding one week weather parameters (one week lag) during *kharif* 2016-17 (Table 3) in field bean crop data revealed that, minimum temperature (-0.293*) had a significant negative correlation with *S.caffer* larval population at p=0.05 level and evaporation (-0.676**) had negatively significant correlation (p=0.01) with plume moth larval population. However, evening relative humidity (0.186*) had a significant positive correlation (p=0.05) with *S.caffer* larval population whereas morning relative humidity (-0.151), rainfall (-0.294), rainy days (-0.331), sunshine hours (-0.137), wind speed (-0.420) and mean temperature (-0.338) were negatively non significant with larval population of plume moth, *S. caffer* (4.7).

3.2.4 Multiple regression for *Kharif* 2016-17

Regression analysis revealed that, all weather parameters collectively influenced the *S.caffer* larval population to the extent of 84.20 per cent (R^2 =0.84%) on field bean (Table 4).

Multiple regression equation was developed for *S.caffer* larval

population with preceding one week weather parameters (one week lag) was presented in Table which indicated that increase in one unit of morning relative humidity, evening relative humidity, rainfall, wind speed and mean temperature resulted in the increase of *S.caffer* larval population by 0.15, 0.20, 3.82, 0.01 and 8.11 units, respectively. Further, with one unit increase in maximum temperature, minimum temperature, rainy days, mean sunshine hours and mean evaporation the larval population was decreased by 1.41, 7.78, 4.49, 0.35 and 0.72 units, respectively.

(a) *Sphenarches caffer* larvae feeding on inflorescence (b) *Sphenarches caffer* adult on inflorescence

Fig 1: *Sphenarches caffer* incidence in field bean

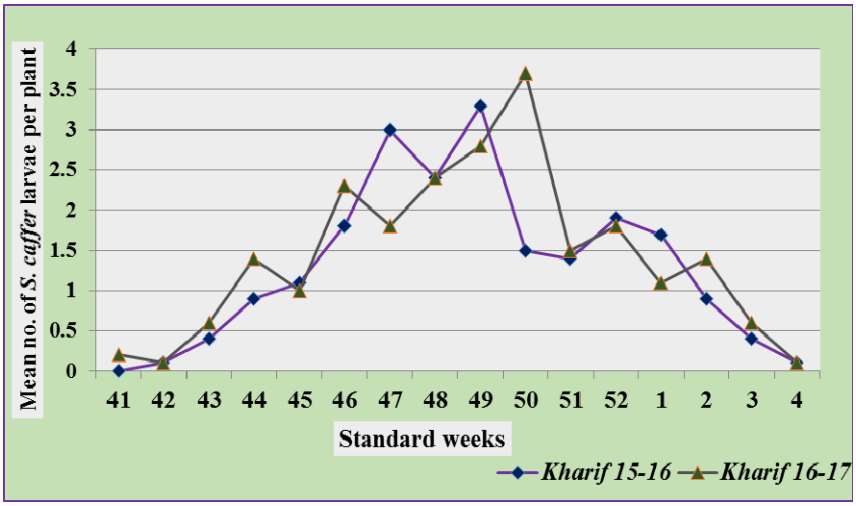

Fig 2: Seasonal incidence of *Sphenarches caffer* on field bean during *kharif* 2015-16 and 2016-17

Table 1: Seasonal incidence of *Sphenarches caffer* larval population in field bean during *kharif* 2015-16

SMW	Date of observation	*S. caffer* Larval population*	Temperature (0C)		Mean Relative Humidity (%)		Rainfall (mm)	Rainy Days	Mean Sunshine (hrs day-1)	Wind speed (km hr-1)	Mean evaporation (mm day-1)	Mean Temp (0C)
			Max.	Min.	I	II						
41	11/10/2015	0.0	33.4	19.6	88.4	37.4	0.0	0	7.9	0.1	4.5	26.5
42	18/10/2015	0.1	32.8	19.1	91.7	42.0	0.0	0	8.4	0.6	4.5	26.0
43	25/10/2015	0.4	32.4	18.1	89.3	43.6	0.0	0	8.9	1.8	4.7	25.3
44	01/11/2015	0.9	31.3	20.7	91.7	50.9	18.3	1	7.3	1.3	3.6	26.0
45	08/11/2015	1.1	31.3	17.4	90.6	73.6	0.0	0	7.3	2.3	4.4	24.3
46	15/11/2015	1.8	30.0	15.8	85.1	52.9	0.0	0	6.7	2.4	4.0	22.9
47	22/11/2015	3.0	29.4	19.1	83.0	53.9	0.8	0	6.6	1.4	3.9	24.2
48	29/11/2015	2.4	30.4	17.8	87.4	47.0	0.0	0	7.7	0.6	3.8	24.1
49	06/12/2015	3.3	29.4	14.4	91.7	36.7	1.4	0	7.0	0.4	3.5	21.9
50	13/12/2015	1.5	32.2	17.0	90.0	37.0	0.0	0	7.6	0.7	3.9	24.6
51	20/12/2015	1.4	32.4	15.7	92.9	35.3	0.0	0	8.9	0.9	4.2	24.1
52	27/12/2015	1.9	30.0	11.1	73.3	24.6	0.0	0	8.8	0.8	3.9	20.6
1	03/01/2016	1.7	30.4	11.8	84.1	26.0	0.0	0	9.6	0.9	3.9	21.1
2	10/01/2016	0.9	29.2	11.0	78.4	25.6	0.0	0	9.1	1.2	3.9	20.1
3	17/01/2016	0.4	29.1	16.6	76.6	36.4	0.0	0	6.8	1.6	3.7	22.9
4	24/01/2016	0.1	29.1	15.6	79.4	37.3	0.0	0	7.2	1.6	3.8	22.4

SMW- Standard Meteorological Week

*Mean no. of insects from 10 plants per plot

Table 2: Seasonal incidence of *Sphenarches caffer* larval population in field bean during *kharif* 2016-17

SMW	Date of observation	*S. caffer* Larval population*	Temperature (0C)		Mean Relative Humidity (%)		Rainfall (mm)	Rainy Days	Mean Sunshine (hrs day-1)	Wind speed (km hr-1)	Mean evaporation (mm day-1)	Mean Temp (0C)
			Max.	Min.	I	II						
41	11/10/2015	0.0	29.9	20.8	94.4	50.9	27.8	3	5.3	0.0	3.1	25.3
42	18/10/2015	0.1	30.6	14.6	92.7	34.1	0.0	0	9.2	0.0	4.0	22.6
43	25/10/2015	0.4	30.2	15.1	91.9	38.3	0.0	0	8.8	0.0	4.1	22.7
44	01/11/2015	0.9	30.9	19.9	84.0	47.1	0.0	0	7.0	0.0	3.6	25.4
45	08/11/2015	1.1	30.1	12.3	88.0	28.7	0.0	0	8.5	0.0	3.8	21.2
46	15/11/2015	1.8	29.8	15.7	88.7	44.9	0.0	0	6.5	0.0	3.3	22.8
47	22/11/2015	3.0	29.7	9.8	89.7	28.1	0.0	0	8.7	0.0	3.6	19.8
48	29/11/2015	2.4	30.8	10.0	90.9	31.4	0.0	0	8.3	0.0	3.3	20.4
49	06/12/2015	3.3	29.1	14.0	92.6	42.3	0.0	0	7.4	0.0	3.1	21.5
50	13/12/2015	1.5	27.9	13.1	86.3	51.3	2.0	0	6.7	0.0	3.1	20.5
51	20/12/2015	1.4	29.4	9.5	88.3	24.0	0.0	0	9.1	0.0	3.6	19.5
52	27/12/2015	1.9	29.4	8.9	91.4	31.0	0.0	0	9.0	0.0	3.5	19.2
1	03/01/2016	1.7	29.1	9.7	89.6	29.7	0.0	0	8.8	0.0	3.4	19.4
2	10/01/2016	0.9	29.3	13.2	84.0	38.0	0.0	0	7.6	0.8	3.4	21.25
3	17/01/2016	0.4	28.2	11.4	89.1	31.7	0.0	0	7.7	1.2	3.6	19.8
4	24/01/2016	0.1	29.9	14.7	85.9	38.4	0.0	0	7.6	3.0	4.3	22.3

SMW- Standard Meteorological Week
*Mean no. of insects from 10 plants per plot

Table 3: Correlation coefficients between plume moth *Sphenarches caffer* larval population and weather parameters (one week lag in field bean during *kharif*, 2015-16 and *kharif* 2016-17

Weather parameters	Correlation coefficients (r)	
	***Kharif* 2015-16**	***Kharif* 2016-17**
Maximum temperature	-0.427*	-0.336
Minimum temperature	-0.243	-0.293*
Morning relative humidity (RH I %)	0.041	-0.151
Evening relative humidity (RH II %)	0.074*	0.186*
Rainfall (mm)	-0.047	-0.294
Rainy days (R.D)	-0.107	-0.331
Sunshine hours (S.S.H)	-0.229	-0.137
Wind speed (W.S) Km/h	-0.129	-0.420
Evaporation (E. pan) (mm)	-0.517*	-0.676**
Mean temperature	-0.352	-0.338

* Significant at 5 % level
* * Significant at 1 % level

Table 4: Multiple regression between larval population of *S. caffer* with weather parameters at one week lag in field bean during *kharif* 2015-16 & 2016-17

Season	Multiple regression equation	Coefficient of determination (R^2)
Kharif 2015-16	$Y = 9.74 + 2.69\ X_1 + 2.95\ X_2 - 0.71\ X_3 + 1.01\ X_4 + 10.86\ X_5 - 11.60\ X_6 + 1.08\ X_7 + 0.36\ X_8 - 1.86\ X_9 - 3.62\ X_{10}$	0.84
Kharif 2016-17	$Y = 4.13 - 1.41\ X_1 - 7.78\ X_2 + 0.15\ X_3 + 0.20\ X_4 + 3.82\ X_5 - 4.49\ X_6 - 0.35\ X_7 + 0.10\ X_8 - 0.72\ X_9 + 8.11\ X_{10}$	0.92

4. Discussion

The incidence of plume moths *viz*., *S. caffer* and *E. atomosa* were observed right from the budding stage and peak incidence was observed during second and third week of November recording 3.2 and3.5 larvae / plant, respectively in field bean [4, 5, 6]. The seasonal incidence of the plume moth, *E. atomosa* was quite active from the second week of November (46th standard week) to second week of February (7th standard week) with its peak was observed during the last week of December (52nd standard week).The least population was recorded in the first week of February (0.2 larvae/ plant) [7].

The plume moth, *E. atomosa* exhibited significant negative correlation with minimum temperature (r = -0.548) [8]. The Plume moth *E. atomosa* on field bean showed highly significant positive correlation with minimum relative humidity (r = 0.65) in field bean crop [9]. The pod borer population in field bean exhibited significant negative correlation with maximum temperature and relative humidity and showed non significant positive correlation with total rainfall [10]. In contrary to the present results the plume moth incidence has no significant correlation with any of the weather parameters in field bean [4].

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